Turbulence in the interstellar medium

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Abstract

The multivariate technique of principal component analysis (PCA) is a powerful statistical tool with which to describe spectral line imaging observations of the molecular interstellar medium. In particular, as formulated by Heyer & Schloerb (1997), PCA can retrieve statistical information about the velocity fields within the interstellar gas. However, the nature of the transformation of the intrinsic velocity *field* onto an observable velocity *axis* is extremely complex if the velocity field is macroturbulent. In this work, PCA is used to show that interstellar velocity fields are characterized by stochastic fluctuations on all measurable scales (i.e., are macroturbulent) and to obtain a quantitative measure of the turbulent velocity dispersion as a function of scale. To relate the measurable statistical information to intrinsic velocity field statistics, an ensemble of artificial density and velocity fields are translated onto the observational domain, utilizing non-LTE radiative transfer calculations. The intrinsic statistical properties of these fields are well-defined and accurately known, which allows the retrieved information to be calibrated to the intrinsic information. Additional results dealing with the instrumental noise and telescope beam-smearing effects on the PCA method are derived and demonstrated. An application of the reformulated method is carried out on an ensemble of outer Galaxy molecular spectral line imaging observations to obtain the first calibrated measurements of interstellar cloud velocity fields. ^

Subject Area

Astronomy

Recommended Citation